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# A NEW SPECIES OF *LINUM* (LINACEAE) FROM THE NORTHERN CHIHUAHUAN DESERT

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## ABSTRACT

A new species, **Linum allredii** R.C. Sivinski & M.O. Howard, is described from gypsum substrates in the Yeso Hills of the northern Chihuahuan Desert in New Mexico and Texas. It is distinguished from its closest relative, *Linum puberulum*, by its suffrutescent habit, glabrous upper stems and upper leaves, and yellow petal bases.

**KEY WORDS**: Linaceae, *Linum*, Chihuahuan Desert, gypsophile.

*Linum* (Linaceae) is usually represented in North America by wide-ranging species. The novelty described here is exceptional and joins a few other narrowly endemic *Linum* species confined to gypsum substrates.

**Linum allredii** R.C. Sivinski & M.O. Howard, sp. nov. (Figs. 1 and 3). **TYPE: USA. New Mexico.** Eddy Co: Yeso Hills, 10.6 air mi (17.1 km) SW of Whites City and 2.3 mi (3.7 km) N of the Texas border, N32.03419°, W104.44791°, WGS84, 3910 ft.; on pale sandy gypsum of the Castile Formation with *Yucca elata*, *Poliomintha incana*, *Hedyotis nigricans*, *Bouteloua breviseta*, *Tiquilia hispidissima*, *Oenothera hartwegii* subsp. *filifolia*, *Nama carnosum*, *Anulocaulis leisolenus* var. *gypsogenus*, *Mentzelia humilis*, *Zeltnera maryanna*, *Polygala alba*; several thousand plants along ridge; always perennial and occasionally producing shoots from large, laterally extending, woody roots; petals orange or salmon with a broad darker or reddish band in the lower interior half above 1-2 mm of yellow at the base – making a round yellow 'eye' at the basal center of the corolla around the ovary; 22 Apr 2011, *M.O. Howard with R.C. Sivinski MOH-132* (holotype: UNM; isotypes: ASU, BRIT, CAS, F, GH, MO, NMC, NY, RM, RSA, SRSC, TEX, US, UTEP).

A *L. puberulo* (Engelm.) Heller habitu suffrutescenti, caulibus distaliter glabris, foliis distalibus glabris, et centris corollarum flavis differt.

**Long-lived perennial**, suffrutescent from a woody branching base, sometimes sprouting shoots from thick, lateral roots. **Stems** erect, up to 25 cm tall, puberulent or glabrescent at the base and glabrous for at least the distal two-thirds. **Leaves** linear to linear-lanceolate, appressed; lower and mid-cauline leaves mucronate, entire, glabrous or weakly puberulent on the margins or midribs, 3–10(–12) mm long; upper leaves acuminate-aristate, serrulate with teeth usually gland-tipped, glabrous, 3–7 mm long. **Stipular glands** dark and present throughout. **Inflorescence** a terminal, few-flowered panicle. **Sepals** lanceolate, acute-aristate, prominently 1-nerved at the midrib, margins serrulate with gland-tipped teeth, glabrous, deciduous in fruit, 4.5–7 mm long. **Petals** broadly obovate, 10–13 mm long, 6–7 mm wide, orange or salmon with a broad adaxial dark orange or

reddish band across the lower half above a short yellow band in the lowest 1–2 mm. **Stamens** 5.5–7 mm long; anthers yellow, 1.2–1.6 mm long. **Styles** 7–9 mm long, united to just below the 5 dark stigmas. **Capsules** oval, stramineous, 3.7–4 mm long, dehiscing into five 2-seeded segments, translucent false septa of segments complete. **Seeds** reddish brown, minutely reticulate, 2.4–2.7 mm long, 0.9–1.1 mm wide.

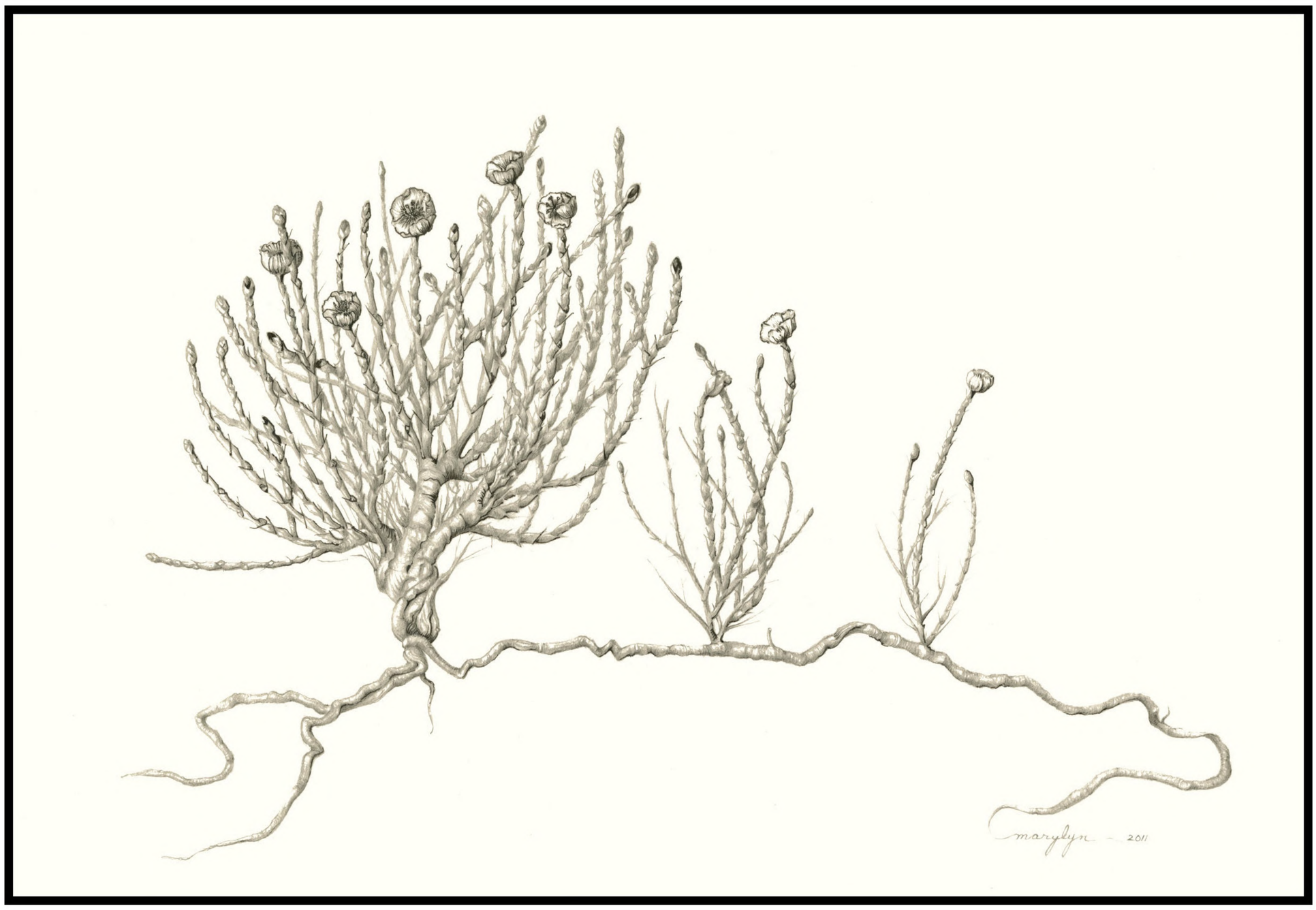


Figure 1. *Linum allredii*, drawn from *Howard with Sivinski MOH-132* (NY).

**Additional Specimens**. **USA. New Mexico**. Eddy Co.: Approximately 32 miles SW of Carlsbad, BLM-Yeso Hills Research Natural Area, T26S R24E S27 SE¼ of SW¼, 3900 ft., 21 May 1992, *Dunmire 1215* (UNM); Yeso Hills, 13.8 air miles SW of Whites City and 0.15 miles N of the Texas border, N32.00509°, W104.49105°, WGS84, 3910 ft., 30 Jul 2008, *Sivinski 6839* (BYU, NMCR, COLO); Yeso Hills, 13.7 air miles SW of Whites City and 0.25 miles N of the Texas border, N32.00375°, W104.49342°, WGS84, 3900 ft., 26 Aug 2010 (in fruit), *Sivinski 7779* (UNM); Yeso Hills, 11.9 air miles SW of Whites City and 0.12 miles NW of Hwy 62/180, N32.02916°, W104.48198°, WGS84, 3915 ft., 22 Apr 2011, *Sivinski with Howard 7976* (UNM); same as type location, 16 May 2011 (in fruit), *Howard MOH-135* (NMC, NMCR). **Texas**. Culberson Co.: approximately 16 air miles SW of Whites City, NM, 2.2 miles S of the junction of U.S. Highway 62/180 and Texas Ranch Road 652, N31.97106°, W104.51560° NAD83, 3895 ft., 16 May 2011, *Howard MOH-134* (SRSC).

**Etymology**. *Linum allredii* is named for Kelly W. Allred, outstanding floristic botanist, agrostologist, bryologist, teacher, and expert at finding and cataloging the plants of New Mexico during his long career as professor of botany in the Animal and Range Science Department at New Mexico State University in Las Cruces.

**Distribution and Habitat**. This new species of flax is currently known only from the Yeso Hills, which occupy an area of approximately 13,000 hectares on the border of New Mexico and Texas between the Guadalupe Mountains and Pecos River. The Yeso Hills comprise a small northern portion of the "Gypsum Plain" that represents the surface exposure of the Permian-aged Castile Formation located between the Guadalupe and Delaware Mountains on the west and the Pecos River in New Mexico and Rustler Hills in Texas on the east (Porch 1918; King 1948; Weber & Kottlowski 1959). Estimated size of the outcropping of the Gypsum Plain is approximately 260,000 hectares and extends approximately 95 km north to south, and from 8 to 50 km wide east to west (Anderson et al. 1997; Barnes et al. 1992).

The Gypsum Plain was described by King (1948) as a wide grassy plain dissected by broad swales that narrow in their upper reaches to shallow canyons with narrow entrenched side canyons that drain eastward to the Pecos River. Superimposed upon the swale/canyon drainage system on most of the western half of the Gypsum Plain is a series of southwest to northeast trending linear scarps. These scarps are from 5 to 15 km in length and are often paired and parallel with a broad swale between them. They likely represent an older drainage system caused by fracturing of the formation (King 1948) and are clearly identifiable on aerial imagery (Fig. 2). In addition to swale/canyon margins and scarps, topography of the Yeso Hills area includes numerous gypsum hills of various sizes on the margins of the Gypsum Plain and within the swales and canyons.

*Linum allredii* appears to be a gypsophilic endemic of the scarps, gypsum hills, and swale/canyon margins of the Gypsum Plain. This species is further limited in distribution to those topographic features that expose a layer of pale, sandy, biologically crusted gypsum that is much lighter in color than the gray more heavily crusted gypsum of adjacent strata. Indeed, the population at the type locality extends in a thin band along light-colored gypsum at the top of a scarp for a distance of over 3 km. Paratype collections on gypsum hills or swale/canyon margins were from smaller outcrops of similar light-colored gypsum. While collections of *L. allredii* are thus far limited to the Yeso Hills, the actual extent of the species may reach further south into the Gypsum Plain of Texas. The numerous scarp lines visible on satellite imagery well south of our southernmost collection suggest the possibility of additional *L. allredii* populations in those areas (Fig. 2).

*Linum allredii* densities at locations seen by the authors in the Yeso Hills range from sporadic hillside groups of a few dozen to a long, narrow population of several thousand individuals along the scarp at the type locality.

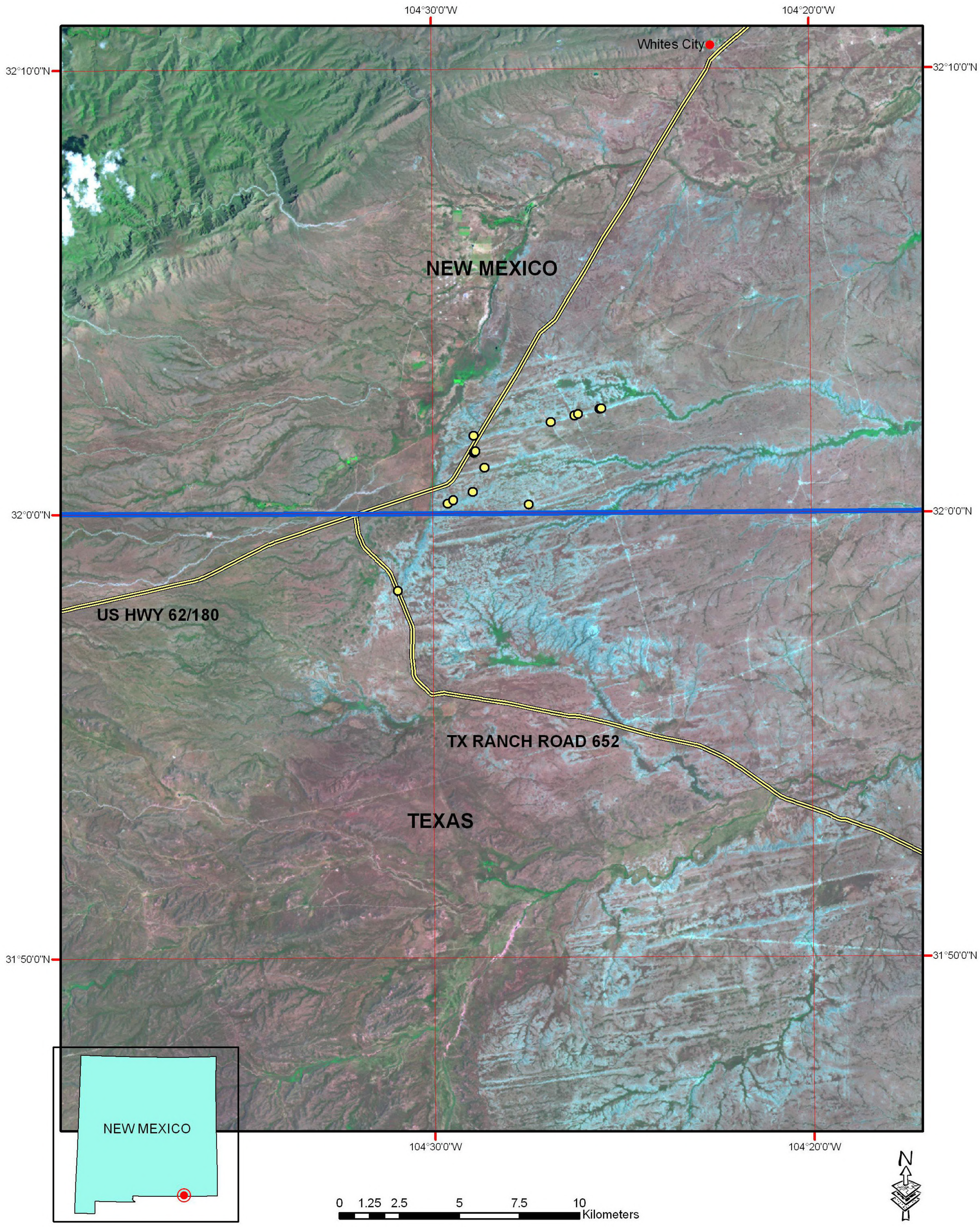


Figure 2. Landsat 7 image overlaid with the distribution of *Linum allredii*. Yellow points indicate collections. Light blue areas represent outcrops of gypsum scarps and hills in the Castile Formation. Primary roads are the yellow lines and the state border is a blue line.

**Morphological distinction of the new species**. *Linum allredii* belongs to the yellow- to orange-flowered *Linum* sect. *Linopsis* subsect. *Rigida*, and to the 5-parted fruit series *Rigida*. It is a strong perennial with a woody, branching base and thick lateral roots. Its short, appressed, aristate leaves, gland-toothed and aristate sepals, orange petals with reddish markings, and fine, short, slightly retrorse pubescence are most similar to *L. puberulum* (Engelm.) Heller, which is common and widespread in the southwestern USA and northwestern Mexico. *Linum puberulum* occurs on a variety of soil types, including gypsum, and is sympatric with *L. allredii* in the Yeso Hills. *Linum puberulum* differs most obviously by its puberulent upper stems and upper leaves and its mostly annual habit. It rarely overwinters as a weak perennial and in those cases retains a slender taproot and does not become woody. *Linum allredii* is consistently glabrous in the distal stems and leaves — if glabrescent or puberulent then only on the lower few centimeters of stem and lowest leaves.

The ability to reproduce asexually by sprouting shoots from lateral roots up to 3 dm away from a parent plant is unique to *Linum allredii* in *Linum* series *Rigida*. Perennial habit in the species of this series is rare and the other perennials do not root sprout. Asexual reproduction in *L. allredii* is interesting but not considered diagnostic because it is more a capability than a tendency. Most individuals remain solitary while only a few sprout multiple clones from lateral roots in response to environmental influences such as soil structure or surface erosion. Approximately 20% of a sample of 106 plants studied at the type locality exhibited surface evidence of distant sprouting and caudex development along lateral roots.

Figure 3. *Linum allredii* habit and flowers, Yeso Hills, Eddy County, New Mexico, 31 July 2008.

*Linum allredii* is an attractive plant with larger floral measurements than most nearby *L. puberulum* populations in New Mexico and Texas. The flowers of each species are readily distinguished by their petal color patterns. The lower interior half of the *L. allredii* corolla is usually a broad reddish or dark orange band above 1–2 mm of yellow at the base of each petal. This makes a round yellow 'eye' at the basal center of the corolla around the ovary (Fig. 3). The corolla of *L. puberulum* is dark at the center because the interior lower half of the petal is reddish and lacks yellow at the base. The yellow-centered orange corolla of *L. allredii* is similar to the corolla color pattern in some forms of *Linum berlandieri* W.J. Hook., which also occur in the northern Chihuahuan Desert region. The annual taprooted habit, larger, attenuate, usually 3-nerved sepals, longer longest leaves (>10 mm), and stouter lower stem hairs of *L. berlandieri* readily separate it from *L. allredii*.

*Linum gypsogenium* Nesom and *Linum modestum* C.M. Rogers are also yellow- or orange-flowered perennials and narrow endemic species confined to local gypsum deposits, but in the Mexican state of Nuevo León (Nesom 1983; Rogers 1984). Their separated styles and fruits dehiscing into 10 one-seeded segments distinguish them from *L. allredii*, which has the united styles and fruits dehiscing into 5 two-seeded segments that are characteristic of the *Linum* series *Rigida*.

## KEY TO *LINUM* SERIES *RIGIDA* IN THE NORTHERN CHIHUAHUAN DESERT REGION

1. Sepals entire or erose, not glandular-toothed ..... **Linum hudsonioides** Planchon
1. Sepals serrulate with gland-tipped teeth.

2. Stems and leaves (at least on the midribs), proximal to distal, markedly puberulent; taprooted annuals or weak perennials ..... **Linum puberulum** (Engelmann) Heller
2. Stems and leaves glabrous throughout or only the proximal sometimes pubescent; taprooted annuals or perennials with woody bases.

3. Plants long-lived perennials, suffrutescent from a branching woody base and thick lateral roots; longest leaves usually 10 mm or less ..... **Linum allredii** Sivinski & Howard
3. Plants taprooted annuals without woody bases; longest leaves 6-30 mm.

4. Sepals tending to persist in fruit; translucent false septa of capsule segments incomplete, inner margin a loose fringe ..... **Linum vernale** Wooton
4. Sepals deciduous in fruit; false septa complete, not fringed on the inner margin.

5. Lower stems glabrous; leaves usually small and inconspicuous; sepals linear-lanceolate ..... **Linum aristatum** Engelmann
5. Lower stems usually sparsely or minutely pubescent; leaves conspicuous; sepals lanceolate.

6. Lower stems minutely and sparsely puberulent; sepals acute-aristate, prominently 1-nerved at the midrib, marginal nerves inconspicuous; petals yellow or orange-yellow without darker or reddish marks below the middle ..... **Linum australe** Heller
6. Lower stems sparsely hirsutulous; sepals attenuate, usually 3-nerved; petals orange or yellow-orange with darker or reddish marks below the middle.

7. Stigmas pale; sepals green ..... **Linum berlandieri** W.J. Hooker var. **berlandieri**
7. Stigmas dark; sepals grayish or purplish ..... **Linum berlandieri** var. **filifolium** (Shinners) C.M. Rogers

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